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Education and job match: The relatedness of college major and work

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Abstract

The match between a worker's education and job has received much attention in the literature. Studies have focused on the match between years of schooling and the schooling required for the job, but the quantity of schooling is only one way to consider the match between schooling and jobs. This paper considers the relationship between college majors and occupations. Data from the National Survey of College Graduates are used to examine the extent to which workers report that their work activities unrelated to the college major. What degree fields lead to greater mismatch is explored as well as the effect on the returns to schooling.

JEL classification: I2; J31

Keywords: Rate of return; Human capital; Educational economics

1. Introduction

Students attend college and select degree fields in the hope of succeeding in the labor market. One aspect of labor market success is the ability to utilize the investment in schooling in future employment. Much research has been performed on the match between worker education and jobs, with the focus on the relationship between the years of schooling required for jobs and completed schooling (e.g., Cohn & Kahn, 1995; Duncan & Hoffman, 1981; Groot & Maassen van den Brink, 2000; Hartog, 2000; Hartog & Oosterbook, 1988; Hersch, 1991; Robst, 1995; Sicherman, 1991). Workers who possess more schooling than their job requires are deemed overeducated, while those with less schooling than required are undereducated.

The quantity of schooling is only one way to consider the match between schooling and jobs. As noted by Sloane (2003), workers may be mismatched if the level of schooling is appropriate but the type of schooling is not. Sloane uses the example of an English major working as a statistician. This paper examines the match between a worker's schooling and job by considering whether the field of study in college is related to the current job. As such, this paper examines mismatch based on the type of schooling. If educational mismatch has important economic

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implications the effects of mismatch between schooling and employment should also exist when looking at alternative concepts of matching.

Research on overeducation links the demand side of the labor market with variability in the returns to schooling for individuals with similar schooling in different jobs (Hartog, 2000). This paper advances the literature on educational mismatch by linking the demand for specific college majors with variation in the returns to education for individuals with similar majors. Data on college graduates are used to examine the match between the college major and job.

Examining this type of education mismatch also contributes to research on college major choice. Individuals select a college major based on a variety of factors including expected earnings (Berger, 1988), patterns of labor force participation (Polachek, 1978), uncertainty (Altonji, 1993), non-price preferences (Easterlin, 1995), and the likelihood of graduation (Montmarquette, Cannings, & Mahseredjian, 2002). The eventual match between degree field and occupation is uncertain when selecting a major. Selecting a college major with greater probability of mismatch involves more uncertainty, with such uncertainty affecting major choice if economic costs to mismatch exist in the form of lower wages. This paper determines whether such costs exist.

In particular, this paper seeks to answer three questions: what proportion of college graduates work in jobs unrelated to their field of study? Which degree fields lead to greater mismatch? Does working outside the degree field affect earnings?

2. Background

Research on educational mismatch has focused on a number of issues. Studies examine the effects of being overeducated on wages, turnover, job satisfaction, and productivity. Hartog (2000) provides an excellent overview of the questions addressed in this area of research.

Overeducation affects wages with the returns to surplus schooling being lower than the returns to required schooling. This result holds regardless of how researchers determine required schooling for a job. Some use subjective measures based on survey questions that ask respondents how much schooling is required for their job. Others use objective measures of required schooling at the occupation level, including a one standard deviation range around the mean level of schooling, the mode level of schooling, and estimates of required schooling provided by labor market experts. The various measures of required schooling provide very different estimates of the prevalence of overeducation, and some individuals are classified as overeducated using one measure and undereducated using another (Robst, 1994).

Some debate has emerged in the literature regarding the reason for the existence of overeducation. The presence of overeducation may be evidence for inefficiencies in the labor market (e.g., Rumberger, 1987). Alternatively, overeducation may be part of an efficient labor market where workers search for jobs throughout their career (Hersch, 1991; Sicherman, 1991). As such, observing someone in a job for which they are overeducated at the beginning of their career is not reason for concern. The training and experience gained through that position enables the person to find a better job.

While the literature on overeducation has grown in the last 20 years, researchers have not expanded the concept of educational mismatch to consider alternative forms of matching. In part this may reflect the emphasis in many countries on increasing educational attainment. Such investments are substantial and it is important to understand whether increasing the average level of education leads to economic growth or merely results in higher educated workers performing the same jobs. Still, workers are matched with jobs based on factors in addition to years of schooling, and it is important to understand other types of worker–job matches as well. One form of educational matching involves the type of schooling, or more specifically the match between an individual's college major and job.

While the eventual match is uncertain when selecting a major, Betts (1996) found that students have significant knowledge about wages. Knowledge is greater about occupations related to the selected major, while wages for occupations associated with other majors tend to be underestimated. Given that students invest in such knowledge when selecting a major, it is anticipated that individuals select a major with the expectation of working in a job related to the field of study.

3. Human capital theory and mismatch

The existence of educational mismatch is consistent with labor market theories including human

capital, job search and matching, and assignment among others (Hartog, 2000). As of yet, research has not determined which theory best explains the existence of educational mismatch, or alternatively whether the existence of overeducation provides support for a particular theory. We provide a brief overview of how human capital theory is used to explain the existence of overeducation. In particular, we focus on overeducation as an investment in human capital, but extend the discussion to consider investments in specific forms of on-the-job training (firm specific, occupation specific and general). Finally, we build the argument to consider mismatch based on the field of study. The same hypotheses could be developed using search or assignment models, but we focus on one theory to keep the exposition clear.

One straightforward argument is that overeducation merely represents a substitution of skills. For example, there may be a trade-off between human capital acquired through formal schooling and human capital acquired through training and experience. An overeducated worker has excess schooling if human capital is not fully utilized in the job. On the other hand, if the person requires additional schooling due to a lack of other forms of human capital (e.g., ability, training, experience), then schooling provides necessary human capital, not excess human capital. In terms of wage effects, overeducated workers earn a lower rate of return on their excess schooling reflecting the cost of worker training or unmeasured factors such as ability and motivation (Bauer, 2002).

Alternatively, being overeducated may represent an investment in experience and training needed to advance in a career (Hersch, 1991; Sicherman, 1991). Workers accept a job for which they are overeducated to receive on-the-job training to enhance future job prospects. As such, being temporarily overeducated is part of the career path for some workers in an efficient labor market. Workers remain in such jobs for relatively short periods of time before moving to jobs that better utilize their skills.

While research has not explored the type of training received by overeducated workers, on-the-job training may provide skills that are firm specific (Hashimoto, 1981), occupation specific (Weiss, 1971; Shaw, 1984, 1987), or completely general. Firm specific skills may increase upward mobility within the firm, while general skills may enhance upward mobility within and across firms. Firm specific and general training are discussed in a multitude of research, but occupational skills are less discussed. Occupational skills reflect the skills an individual requires to work in a specific occupation. Occupational skills are transferable across employers and are thus general in nature. However, while individuals can perfectly transfer such skills across employers, a portion of occupational skills do not transfer to a different occupation. The degree of transferability varies depending on the initial occupation and the subsequent occupation (Shaw, 1987). For example, the occupational skills related to being an engineer may transfer well to being a college professor in engineering, but may not transfer to being a nurse.

Research has shown the specificity of capital affects wages and worker mobility. Shaw (1984) found that occupational skills increase wages, and that occupational and firm specific skills tend to be substitutes with workers tending to concentrate on one. Weiss (1971) develops a model that suggests occupational specific capital leads to less mobility, while Sicherman and Galor (1990) predict that occupational skills lead to greater mobility. Sicherman and Galor assume that such skills are transferable between occupations and individuals invest in skills that lead to better occupations as part of the career path. Similarly, Shaw (1987) finds that occupational mobility is more likely when occupation specific skills are transferable, but that the effect is moderated when the worker abilities are well matched with occupational requirements.

Dolton and Kidd (1998) examined occupational mobility differentiating between occupation specific skills and general skills. They examined the relationship between the type of human capital acquired and the likelihood of changing occupations. The authors found that the acquisition of general skills increases the likelihood of changing occupations, but the acquisition of occupation specific skills reduces the likelihood of changing occupations.

The type of training desired by overeducated workers is likely to vary with individuals expected to pursue the skills most useful for their desired career path. For example, a worker who wishes to move upward within a firm may pursue firm specific skills, while a worker who wishes to stay in the same line of work but not necessarily with the current firm may invest in occupational skills. Finally, workers who wish to change employers and jobs as part of their career may invest in general skills.

3.1. Human capital and mismatch based on degree field

This paper builds on the discussion by relating skill specificity to the skills acquired in college. While research on occupational and general skills focuses on on-the-job training, the choice of major implies an investment in skills necessary to enter a profession related to the chosen major. Some of the skills acquired in college are general while others are specific to the field and desired occupation. As such, the literatures on overeducation and occupational skills can be used to link human capital theory and educational mismatch based on college major.

We assume that individuals select a major with the expectation of working in an occupation related to the field of study. This assumption is consistent with the finding that students invest in more knowledge about occupations related to the selected major (Betts, 1996). When individuals work in jobs unrelated to the college major, this implies choosing an occupation that differs from the intended occupation. As such, it is conceptually similar to a change in occupations. As discussed above, such occupational mobility is greater when skills are general or when skills are transferable from the intended occupation to the chosen occupation.

Several hypotheses are proposed based on studies of occupation specific capital. The first hypothesis relates to the question of which degree fields are associated with greater worker mismatch.

Hypothesis 1. Educational mismatch is more likely among workers with degree fields that provide general skills and less likely among graduates of majors providing occupation specific skills.

Occupational mobility is more likely when the cost to changing occupations is lower. Similarly, entering an occupation that differs from the degree field is more probable when the costs are lower. Some majors focus more on occupation specific skills while others focus more on general skills. General skills transfer to jobs in other fields, while only a portion of occupation specific skills are likely to transfer. Thus, the costs to entering an occupation that differs from the degree field are lower when the degree field focuses on general skills. In terms of specific majors one might expect majors such as engineering and computer science to provide occupation specific skills, while liberal arts and English would provide relatively general skills.

The third question this paper addresses is whether there are wage effects to being mismatched. We develop three hypotheses related to this question.

Hypothesis 2. Workers who are mismatched earn lower wages than well matched workers with the same degree field.

Occupation specific skills related to the current occupation increase wages (Shaw, 1984). Working in a job that differs from the degree field implies using fewer of the occupation specific skills learned by graduates in the major, and as a result, wages are lower for mismatched workers.

Hypothesis 3. Within a major, the wage declines are greater for graduates when fewer skills transfer to the current occupation.

The skills learned in a specific major do not transfer equally to all occupations. Entering an occupation that enables more skills to transfer leads to smaller wage effects.

Hypothesis 4. The wage effects of mismatch are greater in majors that teach occupation specific skills.

While Hypothesis 3 focuses on the wage effects within degree fields, Hypothesis 4 considers wage effects across majors. Skills learned in a college major are not purely general or occupation specific with graduates from all degree fields having a combination of general and occupation specific skills. Some majors teach substantial field specific skills that are not transferable to other fields, leading to negative wage effects to working outside the degree field. On the other hand, some degree fields have substantial general capital that is transferable to other fields, leading to smaller wage effects.

4. Data

The data are derived from the 1993 National Survey of College Graduates (NSCG) from the National Science Foundation. The NSCG consists of a sample of individuals who indicated on the 1990 Census that they had at least a bachelor's degree. NSCG includes an oversampling of certain groups including women, minorities, the disabled, and foreign-born. Observations are weighted to create a nationally representative sample.

Two survey questions are the basis for this paper. The first question asks respondents: "Thinking

about the relationship between your work and your education, to what extent was your work on your principal job held during the week of April 15 related to your highest degree field? Was it closely related, somewhat related, or not related". We consider someone who reports working in a job somewhat related to their major to be partially mismatched, while a person working in a job not related to their degree field is completely mismatched. There are 124,063 responses to this question, and these individuals comprise the final sample.

While responses to this question are subjective, the overeducation literature also uses subjective measures of required schooling. There is little reason to expect responses to the NSCG question to contain more error than questions regarding required schooling. An alternative is to compare the actual degree field with the current occupation. For example, an economics major working as an engineer might be considered to be working in a job unrelated to the degree field. There are many cases, however, when the comparison is less clear. For example, an individual with a degree field in the health professions might or might not be mismatched in a management occupation depending on the specific job. In addition, many college majors provide students with a broad range of skills (e.g., liberal arts) that apply to several different occupations. It would be difficult to develop an algorithm for determining whether a major and job are unrelated. The individual assessments, while perhaps subjective, are expected to provide important information.

Among the other analysis variables is the college major. The NSCG reports 146 distinct fields of study. In order to have adequate sample sizes, majors are grouped into 23 categories. Individuals can report up to three degrees although the survey explicitly asks for the most recent degree. The major for the last reported degree is used since it is more likely related to the current job than a prior degree.

5. Methodology

The goal of the paper is to answer three questions of which two merit discussion in this section. One objective is to determine which degree fields are associated with being mismatched. We estimate an ordered logit regression with an ordered dependent variable denoting whether workers report being partially mismatched or completely mismatched:

$$\Pr(\text{Mismatch})_{ij} = X_{ij}\beta + Z_j\alpha + \varepsilon_{ij}, \tag{1}$$

where X_{ij} includes a vector of demographic variables (a quadratic in age, and categorical variables denoting highest degree, race, disabled, marital status) for individual i in degree field j, and Z_j denotes the degree field. All regressions are run separately for men and women because of the substantial differences in choice of major (e.g., Canes & Rosen, 1995; Polachek, 1978) and career between men and women. All observations are weighted to create a nationally representative sample.

In order to determine whether wage effects exist for this type of mismatch, a standard wage regression is estimated where (the log of) annual wages are regressed on a vector of characteristics:

$$\text{Ln}W_i = X_{ij}\beta + Z_j\alpha + \text{Partial}_{ij}\delta + \text{Complete}_{ij}\mu + \varepsilon_i, \tag{2}$$

where X includes a vector of demographic variables (years of full-time and part-time experience, and categorical variables denoting highest degree, race, disabled, marital status) for person i in degree field j, Z denotes the degree field, *Partial* denotes the person is partially mismatched, and *Complete* completely mismatched. Once again, observations are weighted by the sample weights.

Hypotheses 2 argues that workers who are mismatched earn less than workers employed in jobs related to their field of study. In other words, on average, some human capital acquired in school is occupation specific and is not transferable to jobs in different fields. Thus, both δ and μ are expected to be negative. Hypotheses 3 states that the extent of the wage loss depends on the degree of transferability of skills. We test this hypothesis by comparing wage effects for workers who are partially mismatched to the wage effects for workers who are completely mismatched. Workers who are partially mismatched are assumed to transfer a greater portion of their skills than workers who are in jobs unrelated to their degree field. In other words, we expect the coefficient μ is more negative than δ.

A second specification examines how the wage effects from being mismatched vary across college majors. As such, we interact being mismatched with each degree field. As noted in Hypothesis 4, we expect the wage effects of being mismatched are

greater for graduates of majors providing specific capital.

The first specification is similar to the one in the overeducation literature that controls for completed schooling and includes a categorical variable denoting a worker is overeducated. Overeducated workers earn less than individuals with the same quantity of schooling who are considered adequately educated for their jobs. While useful, the preferred specification in the overeducation literature defines three education variables; years of required schooling, years of overeducation, and years of undereducation. This specification allows researchers to compare the returns to required and surplus schooling. There are no analogous variables for the match based on college major. Conceptually, one must define a measure of the distance between the field of study and the job to measure the extent of mismatch. While beyond the scope of this paper, one possibility is to consider the transferability of skills. Shaw (1987) uses a measure of distance between the initial and subsequent occupation to measure the transferability of skills between occupations. To measure mismatch, the transferability of skills would be based on the distance from the college major to the observed occupation. The development of such an objective measure would be useful to confirm the results of this paper based on subjective reports.

6. Results

6.1. The extent of mismatch

Table 1 contains the distribution of respondent assessments on the relatedness between work and the field of study. Fifty-five percent of individuals report that their work and field of study are closely related, while 25% report that they are somewhat related. Twenty percent of the sample report their field of study and work are not related. Mismatch is reported more often by men, the disabled, and people who have never been married. Among race/ethnic groups, Whites and Asians report more mismatch than Blacks and Hispanics.

Table 1
Match between work and degree field and percentage of respondents working outside their degree field

	Closely related (%)	Somewhat related (%)	Not related (%)
Total sample	54.8	25.1	20.1
Men	52.6	28.3	19.1
Women	57.9	20.8	21.4
White	54.9	25.4	19.7
Black	57.1	22.5	20.3
Asian	52.6	26.5	20.9
Hispanic	58.1	23.3	18.5
Disabled	49.7	25.0	25.3
Non-disabled	55.0	25.1	19.9
Never married	51.9	26.5	21.6
Ever married	55.7	24.7	19.7

Data: 1993 National Survey of College Graduates.

6.2. College major and the likelihood of being mismatched

Table 2 contains the results from the ordered logit regression. The extent of mismatch varies across college major. Relative to the omitted category of computer and information sciences, all majors have a greater likelihood of mismatch except library science and the health professions. Some of the majors with the highest prevalence rates include English and foreign languages, social sciences, and liberal arts. Typically, these majors provide more general skills than occupation specific skills. In addition to computer science, health professions and library science, engineering, engineering technology, architecture, and business management also have low prevalence rates. Among women, education majors also have a low prevalence of mismatch. Most of these majors focus on skills that apply to relatively specific occupations.

While not the focus of this paper, we briefly discuss some of the other results. The likelihood of being mismatched decreases with the level of the most recent degree. Individuals with Masters, Professional, or Doctoral degrees are less likely to be mismatched than Bachelors degree recipients. The likelihood of mismatch increases with age, disability, and is higher for whites and Asians than blacks, Native Americans, or Hispanics. Never married individuals have a greater likelihood of mismatch than those who are married. The results are consistent across men and women.

6.3. Implications for the returns to schooling

The third question this paper addresses is whether being in a job outside the degree field affects the returns to schooling. First, we examine whether

Table 2
Ordered Logit results

	Men			Women		
	Coefs.	Std. err.	Odds	Coefs.	Std. err.	Odds
Intercept(1)	−1.9736	0.124	0.139	−1.7140	0.152	0.180
Intercept(2)	−3.5001	0.125	0.030	−2.8280	0.153	0.059
Degree						
Masters	−0.8600	0.019	0.423	−0.9924	0.022	0.371
Professional	−1.9935	0.068	0.136	−1.8312	0.107	0.160
Other	−0.7751	0.262	0.461	−0.1318	0.227	0.877[ns]
Doctoral	−1.9673	0.043	0.140	−1.7603	0.071	0.172
Demographics						
Age	0.0450	0.005	1.046	0.0373	0.007	1.038
Age sqrd.	−0.0004	0.000	1.000	−0.0003	0.000	1.000
Disabled	0.1786	0.043	1.196	0.1559	0.055	1.169
Black	−0.0796	0.041	0.923[10]	−0.1752	0.037	0.839
Asian	0.1376	0.081	1.148[10]	0.1171	0.086	1.124[ns]
Native	−0.2287	0.169	0.796[ns]	−0.1393	0.187	0.870[ns]
Hispanic	−0.1539	0.059	0.857	−0.2174	0.066	0.805
Foreign born US citizen	0.1384	0.035	1.148	0.2485	0.041	1.282
Foreign born non-US citizen	0.3475	0.039	1.416	0.4553	0.048	1.577
Never married	0.1669	0.022	1.182	0.1545	0.023	1.167
Degree field						
Agricultural sciences	1.2492	0.077	3.488	1.4152	0.135	4.117
Architecture	0.2775	0.097	1.320	0.7313	0.167	2.078
Biological sciences	1.6179	0.071	5.042	1.0135	0.095	2.755
Business management	1.0930	0.058	2.983	0.8616	0.085	2.367
Communications	1.3892	0.073	4.012	1.2063	0.094	3.341
Education	1.2064	0.062	3.341	0.3965	0.084	1.487
Engineering	0.7747	0.061	2.170	0.7625	0.113	2.144
Engineering-related technologies	0.9003	0.078	2.460	1.2469	0.245	3.480
English and foreign languages	2.0556	0.074	7.812	1.4463	0.089	4.247
Health professions	−0.2386	0.079	0.788	−0.4902	0.088	0.613
Home economics	2.1661	0.303	8.724	1.1343	0.099	3.109
Law/prelaw/legal studies	1.0119	0.093	2.751	0.8368	0.141	2.309
Liberal arts	2.3029	0.111	10.003	1.4357	0.117	4.203
Library sciences	−0.1552	0.262	0.856[ns]	0.2236	0.137	1.251[ns]
Mathematics	1.5834	0.076	4.871	1.0704	0.109	2.917
Parks/recreation/fitness studies	1.7571	0.108	5.796	1.1670	0.138	3.212
Philosophy/religion/theology	1.2680	0.074	3.554	1.2623	0.125	3.534
Physical sciences	1.4508	0.068	4.267	1.2067	0.111	3.342
Psychology	1.7720	0.072	5.883	1.2219	0.091	3.394
Public affairs	1.5630	0.103	4.773	1.5091	0.145	4.523
Social sciences	2.0100	0.061	7.463	1.4108	0.086	4.099
Visual and performing arts	1.4495	0.071	4.261	1.2211	0.090	3.391
N	70517			52568		
% Concordant	69.7			68.9		

Notes: Data 1993 National Survey of College Graduates. All coefficients are significant at the 5% level unless otherwise noted; 10 indiciates signficance at the 10% level; ns indicates not significiant at the 10% level.

individuals working outside their degree field earn more or less than individuals working in their degree field. As reported in Table 3, both partially and completely mismatched men and women earn less than workers who report working in the field of study. Thus, being employed in jobs unrelated to the degree field lowers the rate of return to schooling.

Second, we consider whether the transferability of skills alters the wage effects. Skill transferability is accounted for by comparing the wage effects for

Table 3
The wage effects of mismatch

Variable	Men		Women	
	Coefs.	Std. err.	Coefs.	Std. err.
Intercept	15.2600	0.012	15.0300	0.017
Mismatch				
Work not related to degree	−0.1194	0.005	−0.1007	0.006
Work somewhat related to degree	−0.0287	0.004	−0.0213	0.006
Degree				
Masters degree	0.1218	0.005	0.1636	0.005
Professional degree	0.4386	0.011	0.4920	0.015
Other degree	0.0387	0.057[ns]	−0.0076	0.055[ns]
Doctorate	0.2724	0.009	0.3411	0.013
Demographics				
Years full-time experience	0.0111	0.0002	0.0137	0.0003
Years part-time experience	−0.0078	0.0005	−0.0046	0.0006
Disability	−0.1379	0.011	−0.0736	0.013
Black	−0.1423	0.009	−0.0483	0.008
Asian	0.0160	0.019[ns]	0.1035	0.020
Native American	−0.1402	0.040	−0.0658	0.042[ns]
Hispanic	−0.0683	0.013	−0.0013	0.014[ns]
Foreign born US citizen	−0.0331	0.008	0.0353	0.009
Foreign born non-US citizen	−0.1019	0.009	−0.0742	0.012
Never married	−0.1626	0.005	−0.0118	0.005
Training				
Management training	0.1288	0.004	0.1204	0.005
Technical training	0.0271	0.004	0.0315	0.004
General professional training	0.0107	0.004	0.0166	0.005
Other work-related training	−0.0180	0.006	−0.0233	0.006
Degree Field				
Agricultural sciences	−0.3049	0.017	−0.2917	0.032
Architecture	−0.1681	0.020	−0.1315	0.039
Biological sciences	−0.1971	0.015	−0.2467	0.021
Business management	−0.0827	0.012	−0.1410	0.017
Communications	−0.1898	0.016	−0.2169	0.020
Education	−0.3485	0.013	−0.3654	0.017
Engineering	0.0029	0.012[ns]	0.0651	0.024
Engineering-related technologies	−0.1073	0.017	−0.1110	0.059[10]
English and foreign languages	−0.2535	0.017	−0.2722	0.019
Health professions	−0.0183	0.015[ns]	−0.1188	0.018
Home economics	−0.2029	0.076	−0.3771	0.023
Law/prelaw/legal studies	−0.1032	0.017	−0.1791	0.025
Liberal arts	−0.1736	0.027	−0.1598	0.027
Library sciences	−0.4150	0.044	−0.4006	0.026
Mathematics	−0.0498	0.017	−0.1582	0.024
Parks/recreation/fitness studies	−0.3348	0.026	−0.4213	0.033
Philosophy/religion/theology	−0.6150	0.016	−0.4734	0.030
Physical sciences	−0.1145	0.015	−0.1429	0.025
Psychology	−0.2076	0.016	−0.2704	0.019
Public affairs	−0.1613	0.024	−0.1328	0.033
Social sciences	−0.1778	0.013	−0.2665	0.018
Visual and performing arts	−0.3237	0.016	−0.3286	19.000
N	70,619		39,620	
R sqrd.	0.2591		0.2265	

Notes: Data 1993 National Survey of College Graduates. All coefficients are significant at the 5% level unless otherwise noted; 10 indiciates signficance at the 10% level; ns indicates not significiant at the 10% level.

workers who are partially and completely mismatched. The wage effects are much smaller in magnitude for partially mismatched workers than completely mismatched workers. These results indicate that the more transferable skills are from the degree field to the current job, the smaller the wage effects of being mismatched.

Third, we determine how the wage effects vary by degree field. Given the relatively small wage effects from being partially mismatched we focus on workers who report being in jobs unrelated to their degree field. Coefficients on interactions between being mismatched and college major are reported in Table 4. Individuals who majored in business management, engineering, the health professions, computer science, or law all face more than 20% wage penalties for working outside the field of study. The wage effects are insignificant in liberal arts, English, and are statistically significant but small in the social sciences and education. Such

Table 4
The wage effects of mismatch by degree field

Variable	Men		Women	
	Coefficient	Std. error	Coefficient	Std. error
Specification #1				
*Mismatch * degree field*				
Agricultural sciences	−0.0040	0.032[ns]	−0.1834	0.061
Architecture	−0.1529	0.053	−0.0699	0.095[ns]
Biological sciences	−0.0077	0.023[ns]	−0.0783	0.029
Business management	−0.2362	0.009	−0.2263	0.015
Communications	−0.0962	0.026	−0.1390	0.028
Computer and information science	−0.2477	0.046	−0.4106	0.063
Education	0.0092	0.014[ns]	−0.0428	0.011
Engineering	−0.2462	0.017	−0.2776	0.055
Engineering-related technologies	−0.1345	0.040	−0.1712	0.129[ns]
English and foreign languages	−0.0092	0.025[ns]	−0.0240	0.019[ns]
Health professions	−0.3304	0.033	−0.2283	0.024
Home economics	0.0619	0.156[ns]	−0.0500	0.034[ns]
Law/prelaw/legal studies	−0.2746	0.033	−0.2896	0.051
Liberal arts	−0.0582	0.048[ns]	−0.0197	0.043[ns]
Library sciences	0.0774	0.160[ns]	−0.0467	0.077[ns]
Mathematics	−0.1608	0.031	−0.1464	0.043
Parks/recreation/fitness studies	0.1218	0.047	−0.0507	0.064[ns]
Philosophy/religion/theology	0.1819	0.025	0.0780	0.056[ns]
Physical sciences	−0.1296	0.022	−0.1501	0.043
Psychology	0.0531	0.025	0.0004	0.023[ns]
Public affairs	−0.1483	0.057	−0.0657	0.081[ns]
Social sciences	−0.0394	0.012	−0.0518	0.014
Visual and performing arts	−0.0715	0.024	−0.0827	0.021
N	70,619		39,620	
R sqrd.	0.2649		0.2297	
Specification #2				
Mismatch by degree field				
Mismatch	−0.3013	0.012	−0.2283	0.015
Mismatch * mean mismatch in degree field	0.8504	0.049	0.5437	0.056
N	70,619		39,620	
R sqrd.	0.2613		0.2273	

Notes: The dependent variable is the log of annual earnings. The specification also includes years if full-time and part-time experience, and categorical variables denoting highest degree, gender, race, marital status, training, and degree field. Data 1993 National Survey of College Graduates. All coefficients are significant at the 5% level unless otherwise noted; 10 indiciates signficance at the 10% level; ns indicates not significiant at the 10% level.

results support the hypothesis that the wage effects from mismatch as greater in fields that teach occupation specific skills.

It is interesting to note that the wage effects appear most negative in fields with the least mismatch. To confirm this observation, the wage equation was re-estimated including an interaction between the mismatch categorical variable and the proportion of mismatched workers in the major. The coefficient on the interaction was positive and significant indicating that the wage effects are smaller when graduates from the field of study are more likely to be mismatched.

Such results are suggestive that this type of mismatch exists in an efficient labor market. The wage penalties to being mismatched are higher in degree fields where there is less risk of being mismatched. College majors that teach occupation specific skills and thus have the highest penalties to mismatch, produce graduates consistent with market demand. The balance between supply and demand is less of an issue in college majors teaching general skills, since such skills transfer to other occupations.

A number of sensitivity tests were performed. For example, the specification in Table 3 includes 23 broad degree fields. Similar regressions were estimated that included the 146 detailed degree fields. The results for mismatched workers were virtually identical to those reported. Specifications were also tested that control for current occupation. The results indicate that mismatched workers also earn less than other workers in the same occupation.

7. Conclusion

The match between workers' schooling and jobs has been the focus of considerable research. Prior research has focused on the match between the quantity of schooling and years of schooling required for the job. This paper took a different look at the issue by considering the match between employment and the field of study in college. Forty five percent of workers report that their job is only partially related or not related to their field of study.

Workers who are mismatched earn less than adequately matched workers with the same amount of schooling. The wage effects in this paper vary depending on the field of study. Graduates from majors that emphasize general skills (e.g., liberal arts) have a higher likelihood of mismatch, but relatively low costs to be mismatched. Some majors emphasize occupation specific skills and mismatched workers incur substantial costs.

Mismatch appears to exist in an efficient labor market. As such, mismatch based on college major does not necessarily imply a substantial imbalance in the college education market. The costs to mismatch, in the form of lower wages, are greatest in college majors with the least mismatch. Such a finding suggests that the allocation of students across majors reflects the rewards available in the labor market.

Despite educational mismatch existing in an efficient labor market, such findings have implications for the decisions faced by students when selecting a college major. Prior research shows one factor that students should consider is the likelihood that they will be able to finish the degree in their major of choice (Montmarquette et al., 2002). This paper suggests that students should also consider the potential for finding employment in a job related to that major. Being unable to find employment reduces the returns to schooling for many majors. As such, before choosing a major that focuses on occupation specific skills, students should be advised to make sure it is what they wish to pursue in their career. The cost to changing careers after getting the degree can be high.

One should not examine the wage effects of mismatch without considering the role of ability. A referee suggested that the negative wage effects to ability may reflect a sorting bias, where ability is negatively related to being mismatched among graduates within a major. As such they earn lower wages due to lower ability not necessarily because of mismatch. Such an argument is certainly plausible and must be addressed. Unfortunately, the NSCG has no information on tests or other measures that can proxy for ability. Alternatively, an instrumental variables approach could be used, but it is doubtful that one could find an instrument highly correlated with the probability of mismatch that is uncorrelated with wages.

There are a couple of reasons why unobserved heterogeneity might not be crucial to the results. First, one would expect to find a distribution of ability in all majors. If the lower returns to being mismatched were simply reflecting ability, then the wage effects to mismatch should be evident across all majors. However, substantial differences exist across majors suggesting that we are not simply observing the tail of the ability distribution in each major. Second, the issue of unobserved heterogene-

ity and sorting is most important if mismatch is due to a lack of jobs related to the college major. If individuals *choose* to enter a different occupation, then such a choice may or may not be related to ability. The NSCG asks question related to the reason for accepting work unrelated to the degree field. Fewer than 20% or men and women report the most important reason for accepting such a job was because work related to the degree field was not available. Still, the issue of unobserved heterogeneity is an important issue for future research.

Future research could address a number of additional issues as well. As discussed earlier, objective measures of mismatch are useful to corroborate findings from subjective measures. Such measures should focus on the relative specificity of college majors and the transferability of skills across occupations. In addition, this paper largely asserts which majors provide general and occupation specific capital. Examining the transferability of skills using the distance measures employed by Shaw (1984, 1987) would explicitly test which majors transfer the most skills. In other words, which majors focus on general skills and which focus on occupation specific skills. Last, studies of college major choice could include the probability of mismatch to determine whether students avoid such majors, *ceteris paribus*.

References

Altonji, J. G. (1993). The demand for and return to education when education outcomes are uncertain. *Journal of Labor Economics*, *11*(1), 48–83.

Bauer, T. K. (2002). Educational mismatch and wages: A panel analysis. *Economics of Education Review*, *21*(3), 221–229.

Berger, M. C. (1988). Predicted future earnings and choice of college major. *Industrial and Labor Relations Review*, *41*(3), 418–429.

Betts, J. R. (1996). What do students know about wages? Evidence from a survey of undergraduates. *Journal of Human Resources*, *31*(1), 27–56.

Canes, B. J., & Rosen, H. S. (1995). Following in her footsteps? Women's choice of college majors and faculty gender composition. *Industrial and Labor Relations Review*, *48*(3), 482–504.

Cohn, E., & Kahn, S. (1995). The wage effects of overschooling revisited. *Labour Economics*, *2*(1), 67–76.

Dolton, P. J., & Kidd, M. P. (1998). Job changes, occupational mobility and human capital acquisition: An empirical analysis. *Bulletin of Economic Research*, *50*(4), 265–295.

Duncan, G., & Hoffman, S. (1981). The incidence and wage effects of overeducation. *Economics of Education Review*, *1*(1), 75–86.

Easterlin, R. A. (1995). Preferences and prices in choice of career: The switch to business, 1972–1987. *Journal of Economic Behavior and Organization*, *27*(1), 1–34.

Groot, W., & Maassen van den Brink, H. (2000). Overeducation in the labor market: A meta-analysis. *Economics of Education Review*, *19*(2), 149–159.

Hartog, J. (2000). Over-education and earnings: Where are we, where should we go? *Economics of Education Review*, *19*(2), 131–147.

Hartog, J., & Oosterbook, H. (1988). Education, allocation, and earnings in the Netherlands: Overschooling? *Economics of Education Review*, *7*(2), 185–194.

Hashimoto, M. (1981). Firm specific human capital as a shared investment. *American Economic Review*, *71*(3), 475–482.

Hersch, J. (1991). Education match and job match. *The Review of Economics and Statistics*, *73*(1), 140–144.

Montmarquette, C., Cannings, K., & Mahseredjian, S. (2002). How do young people choose majors? *Economics of Education Review*, *21*(6), 543–556.

Polachek, S. (1978). Sex differences in college major. *Industrial and Labor Relations Review*, *31*(4), 498–508.

Robst, J. (1994). Measurement error and the returns to excess schooling. *Applied Economics Letters*, *1*(9), 142–144.

Robst, J. (1995). Career mobility, job match, and overeducation. *Eastern Economic Journal*, *21*(4), 539–550.

Rumberger, R. (1987). The impact of surplus schooling on productivity and wages. *Journal of Human Resources*, *22*(1), 24–50.

Shaw, K. L. (1984). A formulation of the earnings function using the concept of occupational investment. *Journal of Human Resources*, *19*(3), 219–340.

Shaw, K. L. (1987). Occupation change, employer change, and the transferability of skills. *Southern Economic Journal*, *53*(3), 702–719.

Sicherman, N. (1991). Overeducation in the labor market. *Journal of Labor Economics*, *9*(2), 101–122.

Sicherman, N., & Galor, O. (1990). A theory of career mobility. *Journal of Political Economy*, *98*(1), 169–192.

Sloane, P. J. (2003). Much ado about nothing? What does the over-education literature really tell us? In F. Büchel, A. deGrip, & A. Mertens (Eds.), *Overeducation in Europe: Current issues in theory and policy* (pp. 11–48). Cheltenham, UK: Edward Elgar.

Weiss, Y. (1971). Learning by doing and occupational specialization. *Journal of Economic Theory*, *3*(2), 189–198.